REMARKS

Further and favorable reconsideration is respectfully requested in view of the foregoing amendments and following remarks.

Thus, the title of the invention on page 1 of the specification has been amended as required by the Examiner.

Claims 7 and 9 have been amended to overcome the objection to these claims, it being noted that the Examiner's suggested amendment for claim 9 has been adopted. As a result of these amendments, the objection to claims 7 and 9 is considered to be moot.

Claim 3 has been amended to overcome the rejection of this claim under the second paragraph of 35 U.S.C. § 112, as a result of which this rejection is moot.

Claim 1 has been amended to narrow the range for the inherent viscosity of the vinylidene fluoride copolymer to 1.7 to 7 dl/g, which is the preferred range for the inherent viscosity disclosed at page 6, line 6 of the specification.

Claim 2 has been rewritten in independent form, in consideration of the Examiner's comment in item 10 of the Office Action that this claim would be allowable if rewritten in independent form including all of the limitations of the base claim (claim 1) and any intervening claims (none). Accordingly, claim 2 is now considered to be allowable.

Attached hereto is a marked-up version of the changes made to the Specification and claims by the current amendment. The attached pages are captioned "**Version with markings to show changes made.**"

The patentability of the present invention over the disclosures of the references relied upon by the Examiner in rejecting the claims will be apparent upon consideration of the following remarks.

The present invention

As discussed at page 8, line 20 to page 10, line 10 of the present specification, the vinylidene fluoride copolymer constituting the polymer electrolyte of claim 1 is characterized by a high liquid-retentivity (i.e., a high retentivity of electrolytic solution directly leading to a high electrolyte performance) even at a high vinylidene fluoride content (favoring a high mechanical strength),

because of a high molecular weight as represented by an inherent viscosity of 1.7 to 7.0 dl/g (as in amended claim 1 for the purpose of further clarifying the high molecular weight).

Such advantages resulting from the use of a high molecular weight vinylidene-fluoride copolymer for constituting a polymer electrolyte are clearly demonstrated in the Examples and Comparative Examples of the present application.

The rejections

The rejection of claims 1, 3-6, 8 and 9 under 35 U.S.C. § 102(b) or 35 U.S.C. § 103(a) based on EP 730316 A1, as well as the rejection of claims 1 and 3-9 under 35 U.S.C. § 102(e) or 35 U.S.C. § 103(a) based on Mitchell et al. and the rejection of claims 1 and 3-9 under 35 U.S.C. § 102(e) or 35 U.S.C. § 103(a) based on Gozdz et al. '891, are respectfully traversed.

In contrast to the present invention as discussed above, all of these references disclose polymer electrolytes for lithium batteries comprising a vinylidene fluoride copolymer, but they all fail to disclose or suggest the use of a vinylidene fluoride copolymer having such a high molecular weight as in the case of the present invention.

EP '316 discloses in Table III at page 9 several vinylidene fluoride-hexafluoropropylene (VdF-HFP) copolymers, KYNAR 2800GL, 2800RL, 2850 and 2900 (also see Table II at page 8, and Table IV at page 10), having weight-average molecular weights (Mw) ranging from 232,500 to 497,200 as measured by GPC (gel permeation chromatography).

Gozdz et al. '891 discloses the use of VdF-HFP copolymers preferably having a molecular weight (believed to be Mw rather than Mn) of 200×10^3 to 400×10^3 and an intrinsic viscosity in acetone of 1.1-1.6 dl/g at 25°C, at column 5, lines 49-52. Kynar FLEX 2822 is used in Example 1 at column 8.

Mitchell et al. does not contain any disclosure concerning the molecular weight of the vinylidene fluoride copolymer which would indicate that such copolymer has an inherent viscosity within the presently claimed range.

Table I attached hereto lists various data showing correlations between inherent viscosity (η_{inh}) and number-average molecular weight (Mn), weight-average molecular weight (Mw) measured

by GPC for various grades of VdF-HFP copolymers, gathered by Mr. Katsurao (the principal inventor of the present invention), including FD-series copolymers and #81 and #82-series copolymers prepared in Kureha (the Assignee company) and Kynar FLEX-series copolymers 2801, 2822 and 2850. As suggested by the data in Table I, the claimed inherent viscosity (η_{inh}) level of $\geqq$ 1.70 dl/g roughly corresponds to Mw $\geq 50 \times 10^4$, and the Kynar-series copolymers (2801, 2822 and 2850) as used in the cited references all exhibited Mw values substantially lower than 50×10^4. EP '316 shows some higher Mw values of 497,200 for 2800GL and 454,700 for 2850 in Table III, but these are still lower than 50×10^4. Incidentally, Kynar FLEX 2800 is referred to as equivalent to "2801" except for its physical form (line 20 in Table IV at page 10).

The discussion of the molecular weight levels is somewhat expanded below based on available data.

Fig. A attached hereto shows changes in solution viscosity (y:dl/g) depending on polymer concentration for VdF-HFP copolymer having three η_{inh} levels of 0.85, 1.10 and 1.70 dl/g. The solution viscosities extrapolated to a concentration of 0 dl/g represent three intrinsic viscosity [η] values of the three copolymers in Fig. A, and Fig. B represents a relationship between inherent viscosity η_{inh} values and intrinsic viscosity [η] values thus-obtained. Figs. A and B both clearly show that [η] gives higher values (ca. 0.9, 1.2 and 1.9) than η_{inh} values (= 0.85, 1.10 and 1.70) used in claim 1 for identical copolymers. Thus, intrinsic viscosity [η] levels of 1.10-1.60 dl/g disclosed by Gozdz et al. '891, column 5, line 52 represent substantially lower molecular weights than those represented by inherent viscosity $\eta_{inh} \geqq 1.70$ dl/g.

The data shown in Table I discussed above are recast in Fig. C attached hereto as spots representing a relationship between inherent viscosity η_{inh} and molecular weights (Mw and Mn). Fig. C also shows smaller molecular weight levels of Kynar-series VdF-HFP copolymers than those represented by $\eta_{inh} \geqq 1.7$ of the present invention. Deviations of the data for Kynar-series copolymers from linear lines given by the Applicants' copolymer data are attributable to larger molecular weight dispersion factors (Mw/Mn ratios) of the Kynar-series copolymers as already understood from the data in Table 1.

Based on the above discussion and available molecular weight data, it is apparent that the vinylidene fluoride copolymers disclosed in the cited references have substantially lower molecular weights than the vinylidene fluoride copolymer represented by $\eta_{inh} \geqq 1.70$ dl/g of claim 1.

The significance of using a VdF copolymer having a higher molecular weight ($\eta_{inh} \geqq 1.70$ dl/g) is clear from Examples in comparison with Comparative Examples 1-3 using a VdF copolymer having $\eta_{inh} = 1.20$ dl/g (Kynar FLEX 2801), as set forth in the present specification.

Accordingly, the present invention directed to a polymer electrolyte comprising a VdF copolymer having such a high molecular weight as represented by $\eta_{inh} \geqq 1.70$ dl/g is not believed anticipated by or obvious over the cited references.

Therefore, in view of the foregoing amendments and remarks, it is submitted that each of the grounds of objection and rejection set forth by the Examiner has been overcome, and that the application is in condition for allowance. Such allowance is solicited.

Respectfully submitted,

Takumi KATSURAO et al.

By: Michael R. Davis
Registration No. 25,134
Attorney for Applicants

MRD/aeh
Washington, D.C. 20006-1021
Telephone (202) 721-8200
Facsimile (202) 721-8250
April 30, 2002

THE COMMISSIONER IS AUTHORIZED TO CHARGE ANY DEFICIENCY IN THE FEES FOR THIS PAPER TO DEPOSIT ACCOUNT NO. 23-0975

VERSION WITH MARKINGS TO SHOW CHANGES MADE

Please rewrite the title of the application as follows:

POLYMER ELECTROLYTE CONTAINING A VINYLIDENE FLUORIDE COPOLYMER AND A NONAQUEOUS ELECTROLYTIC SOLUTION, AND NONAQUEOUS BATTERY CONTAINING THE POLYMER ELECTROLYTE [SAME]

1. (Amended) A polymer electrolyte, comprising: a vinylidene fluoride copolymer and a nonaqueous electrolytic solution, wherein the vinylidene fluoride copolymer comprises 80 to 97 wt. % of vinylidene fluoride monomer units and 3 to 20 wt. % of units of at least one monomer copolymerizable with vinylidene fluoride monomer and has an inherent viscosity of 1.7 to 7 [1.5 to 10] dl/g.

2. (Amended) A polymer electrolyte [according to Claim 1], comprising: a vinylidene fluoride copolymer and a nonaqueous electrolytic solution, wherein the vinylidene fluoride copolymer comprises 80 to 97 wt. % of vinylidene fluoride monomer units and 3 to 20 wt. % of units of at least one monomer copolymerizable with vinylidene fluoride monomer and has an inherent viscosity of 1.5 to 10 dl/g, and wherein said at least one monomer copolymerizable with vinylidene fluoride comprises a mixture of hexafluoropropylene monomer and trifluorochloroethylene monomer.

3. (Amended) A polymer electrolyte according to Claim 1, wherein the vinylidene fluoride copolymer has been obtained by introducing [charging] the monomers simultaneously all at once into a polymerization vessel and then polymerizing the monomers.

7. (Amended) A polymer electrolyte according to Claim 4, wherein the vinylidene fluoride copolymer is crosslinked in the presence of (1) a crosslinking agent selected from the group consisting of polyamines, polyols and polymerizable crosslinking agents having an unsaturated bond, and (2) a radical generating agent.

9. (Amended) A nonaqueous battery, comprising: a positive electrode comprising a positive electrode material capable of being doped with and liberating lithium, a negative electrode comprising <u>either metallic lithium or</u> a negative electrode material similarly capable of being doped with and liberating lithium [or metallic lithium], and a polymer electrolyte according to any of Claims 1-8 between the positive electrode and the negative electrode.

Table I: Data of P(VDF-HFP) Copolymer Samples

Sample	η inh [dl/g]	Mn [10^4]	Mw [10^4]	Mw/Mn
FD-2371	2.240	30.0	69.4	2.31
FD-2412	2.080	29.8	62.3	2.09
FD-2405	2.030	27.7	58.6	2.11
FD-2441	2.005	27.3	59.0	2.16
FD-2437	2.001	26.8	59.8	2.23
FD-2398	1.980	26.8	58.3	2.18
FD-2413	1.967	26.5	56.6	2.14
FD-2385	1.960	26.9	57.2	2.13
FD-2440	1.955	26.5	57.6	2.18
FD-2401	1.943	25.9	56.3	2.18
FD-2372	1.934	26.2	55.9	2.13
FD-2414	1.932	26.3	56.4	2.15
FD-2404	1.931	26.3	56.9	2.16
FD-2407	1.915	25.0	54.6	2.19
FD-2410	1.910	25.3	55.3	2.19
FD-2431	1.891	25.6	54.3	2.12
FD-2419	1.890	25.2	55.2	2.19
FD-2433	1.885	24.9	55.1	2.22
FD-2436	1.879	24.6	54.3	2.21
FD-2427	1.875	25.0	55.6	2.22
FD-2428	1.874	26.4	55.7	2.11
FD-2432	1.874	25.5	55.2	2.16
FD-2426	1.873	25.1	55.9	2.23
FD-2421	1.865	25.7	55.4	2.16
FD-2424	1.841	25.2	53.4	2.12
FD-2388	1.830	24.2	52.1	2.16
FD-2418	1.825	23.6	53.0	2.25
FD-2390	1.790	24.6	52.6	2.14
FD-2425	1.240	13.8	32.4	2.34
FD-2377	1.160	14.2	29.6	2.08
FD-2408	0.920	9.8	21.3	2.17
FD-2403	0.918	9.7	21.7	2.22
FD-2415	0.918	9.8	21.4	2.18
FD-2384	0.916	10.0	21.8	2.19
FD-2411	0.910	9.8	21.1	2.16
FD-2417	0.904	9.7	21.0	2.16
FD-2420	0.895	9.6	20.8	2.16
FD-2430	0.892	9.4	20.6	2.18
FD-2435	0.886	9.3	20.3	2.17
FD-2423	0.882	9.6	20.7	2.14
FD-2400	0.879	9.6	20.6	2.14
FD-2422	0.873	9.4	20.3	2.17
FD-2393	0.761	8.4	16.4	1.94
FD-2593	1.474	18.2	43.9	2.42
FD-2598	1.364	14.8	40.5	2.73
FD-2599	1.324	13.2	39.2	2.98
FD-2602	1.308	13.6	39.5	2.90
FD-2606	1.366	14.2	41.0	2.90
FD-2609	1.262	17.9	35.8	2.00
FD-2610	1.823	26.8	58.3	2.17
FD-2613	1.504	21.9	44.8	2.04
FD-2667	1.013	12.0	26.5	2.21
FD-2670	0.873	9.8	23.4	2.39
FD-2671	1.320	16.5	38.9	2.35
FD-2761	0.903	10.3	22.6	2.20
FD-2772	0.973	13.2	25.2	1.91
FD-2773	0.977	12.6	24.7	1.96
FD-2892	1.977	33.6	67.7	2.02
FD-2897	2.152	33.4	71.5	2.14
#81-1	0.900	10.6	24.8	2.35
#82-1	1.910	31.0	62.4	2.01
#81-2	0.900	10.4	23.9	2.30
#81-3	0.900	10.6	23.9	2.24
#82-2	1.910	23.0	62.9	2.73
#82-3	1.910	21.1	62.4	2.95
Kynar 2801	1.236	13.0	38.2	2.94
Kynar 2822	1.103	11.3	32.2	2.85
Kynar 2850	1.111	11.8	33.1	2.81

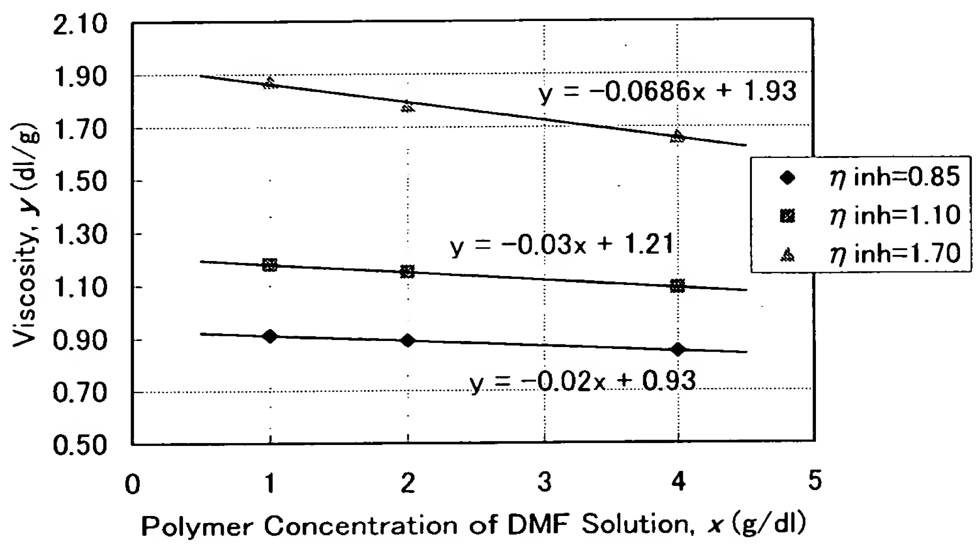

Fig.A: Polymer Conc. vs Viscosity

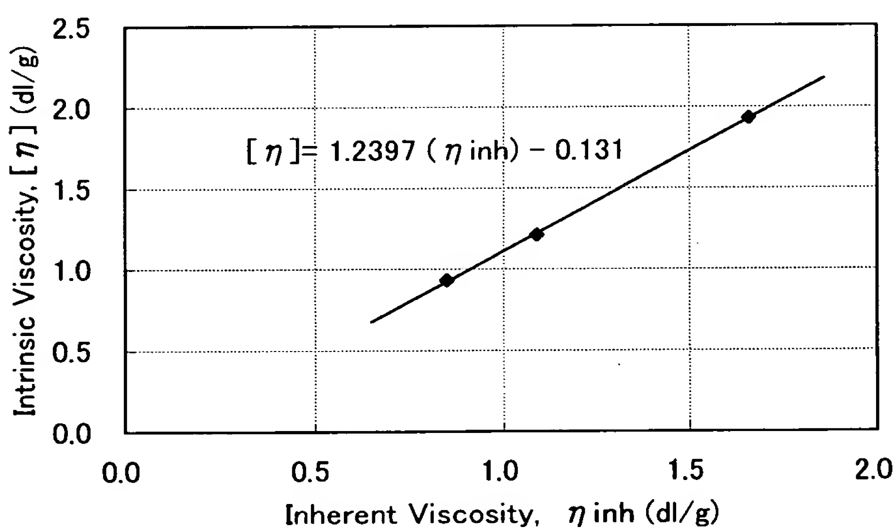

Fig.B: Relationship between Inherent Viscosity and Intrinsic Viscosity

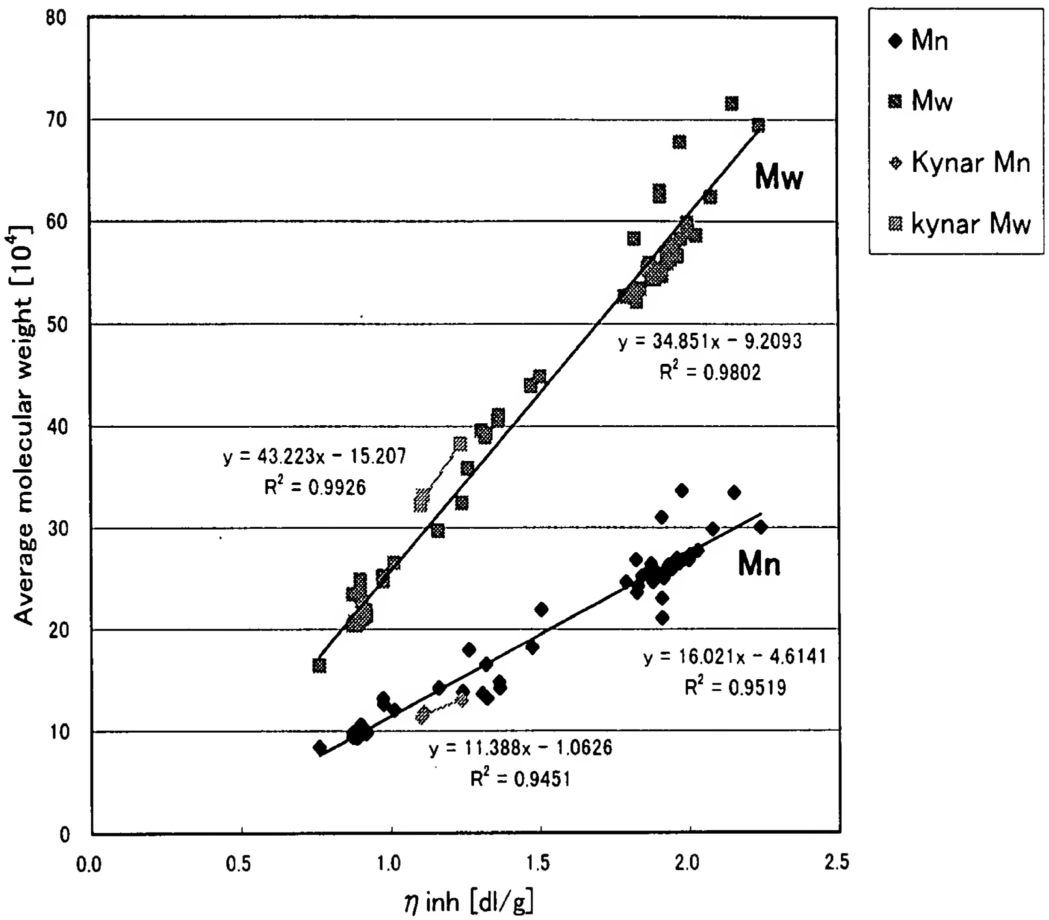

Fig.C: Relationship between η inh and Average Molecular Weight